Insights

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Ontario Forest Research Institute
OFRI • IRFO

Forest science faces 21st-century challenges

By David DeYoe, OFRI General Manager

Over the last 50 years, forest research has changed dramatically. Early on, the focus was on how to grow more trees faster to improve opportunities for profits and jobs. Today, it has broadened to include sustaining whole forest ecosystems and all their values: economic, social, cultural, and environmental. As we move into the 21st century, this expanding focus – coupled with shrinking budgets – will present resource professionals with dramatic challenges and opportunities. This issue of *Insights* addresses just a few of these:

- **Measuring forest condition:**

  The mandate is clear. Resource managers at all levels, whether in government or private industry, *must* be able to provide scientifically sound evidence that they are managing forests sustainably. However, the information gap is huge. We need effective, practical ways of assessing forest condition at appropriate scales. At OFRI, one promising new project is looking at how to use remote sensing to scale tree-level stress-assessment techniques up to the forest stand (see Page 2).

- **Understanding and preparing for climate change:**

  If, as many scientists believe, climate change will be so dramatic that Sudbury will have the climate of Windsor by the end of the next century, the genetic, ecological and economic consequences could be enormous. However, scientists are only just beginning to understand and be able to predict the potential impacts at a scale that enables local and regional planning (see Page 3).

- **Preparing for the millennium:**

  How do we meet the increasing resource-management challenges – with fewer people and shrinking budgets? By working smarter: aligning science priorities/goals with business objectives, tackling the highest priorities first, and being flexible enough to change gears as needed. This issue of *Insights* profiles a research program that's now tackling these challenges (see Page 5).

As we begin to take on the challenges of the next millenium, we would do well to remember how the Chinese view *crisis* and *opportunity*: as flip sides of the same entity. The choice is ours.

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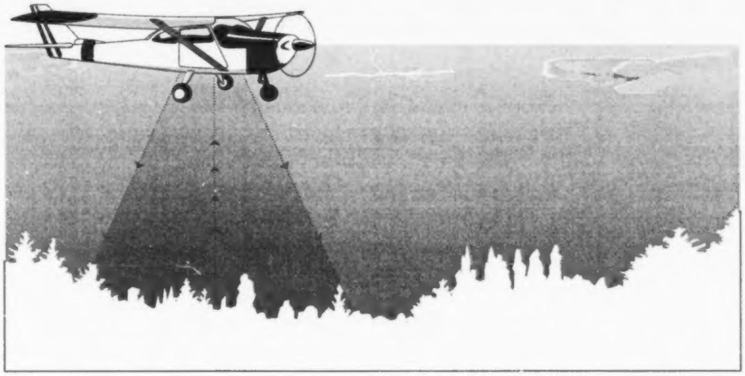
Cette publication technique n'est disponible qu'en anglais.

Biondicators Project to develop new approach for monitoring forest condition

By Abigail M. Obenchain

By early next century, researchers with OFRI's Bioindicators Project may be testing a Forest Condition Rating System that can detect forest decline *before* physical symptoms appear – and before it's too late to act.



According to project coordinator Paul Sampson, this system will likely rely on *remote sensing imagery*. Remote sensing uses special equipment mounted on an airplane or satellite to collect data, in this case the forest canopy's *spectral signature* (the pattern of sunlight that leaves reflect). Supporting this *hyperspectral* technology will be a large information base and ground-based tools for interpreting what these patterns indicate about a forest's physiological condition.

"Traditional measures of forest condition have focussed on *physical* characteristics, such as increases in tree volume," Sampson says. "However, physical changes may not be evident until after extensive damage has occurred, and collecting physical data is labour intensive and expensive. Thus a system based on tree *physiology* — what's happening inside the trees — would fill a critical gap in the forest-monitoring toolkit."

Sampson emphasizes that this project is still in the developmental stage and that it's too soon to know if an operational application is feasible. However, he and his colleagues are optimistic, not surprising given that they have extensive experience in researching individual-tree physiology, resulting in innovations such as OFRI's Stock Quality Assessment Program (see *Insights* Vol. 1, No. 1). Scientist Gina Mohammed points out, "We are scaling physiologically based assessment up to the stand level and possibly beyond, which may require a different approach than we've used for assessing individual-tree physiology."

Forest managers could use this new approach to:

- Identify which stands should be thinned or harvested early due to stress
- Evaluate the effects of forest management practices
- Indicate whether forests are being managed sustainably
- Provide forest condition profiles for state-of-the-resource reports

Because the current investigations are complex, the research team has been focussing mostly on existing hardwood plots in the Algoma Region. However, some data have been collected for other species as well. Ground-based information is being collected not only from trees in the forest but also from seedlings subjected to various stresses in controlled studies in the lab, in the greenhouse, and at OFRI's Arboretum. As Mohammed points out, "All kinds of biological processes contribute to spectral signatures, and there's a tremendous amount of work involved in determining how to read them. For example, particularly in a declining stand, the light reflected by the understory vegetation can interfere with reading the overstory's spectra. Resolving this problem may involve modifying how we conduct the remote sensing, for example, by positioning the equipment at an angle to capture only canopy reflectance, as well as careful data analysis to link variations in spectral signatures to physiological status."

In a related study, OFRI scientist Steve Colombo is looking at tree rings to help determine how the signature of a "normal" forest differs from that of a forest under stress. "Tree rings contain permanent records of tree stress," he explains. "These rings are composed mostly of cellulose, which contains carbon atoms absorbed by the tree during photosynthesis. Most carbon atoms contain 6 neutrons and 6 protons and are designated ^{12}C. A small percentage of carbon atoms are designated ^{13}C, because they contain an extra neutron and thus have more mass. The more ^{13}C a ring contains, the greater the stress the tree experienced during that growing year." He continues, "Analyzing tree rings helps us to detect long-term changes in forest stress, develop baseline values for a 'normal' forest, and groundtruth the remote-sensing data."

According to Mohammed, OFRI's Bioindicators team has established several partnerships with researchers

and resource professionals in universities, other research organizations, and industry. Two examples: John Miller, a renowned York University professor and director of the Earth Observations Laboratory at the Centre for Research in Earth and Space Technology, has become the project's remote-sensing expert and has secured a grant from NASA for a complementary study. And E.B. Eddy is providing information on jack pine stands managed by the company for an OFRI-Canadian Forest Service study that will focus on sensing budworm damage. "In these stands, the jack pine budworm is at an all-time low in its cycle, thus it's a terrific time to get baseline data," says OFRI scientist Tom Noland. "This study should help us determine how to use remote sensing to detect signs of stress *before* the budworm cycle shifts into high gear. We hope that this work will result in a remote-sensing tool that MNR and industry could use to detect potential jack pine budworm outbreaks at an early stage."

Many other studies will feed into the Bioindicators Project, the ultimate goal of which is to create not just an assessment tool but also a provincial Forest Condition Rating System. For more information, see *Bioindicators of Forest Sustainability: Development of a Forest Condition Rating System for Ontario* (OFRI Forest Research Information Paper No. 137) or *Bioindicators of Forest Sustainability Progress Report* (OFRI Forest Research Information Report No. 142).

Project contact: Gina Mohammed at OFRI (ext. 214; mohammg@gov.on.ca). Other OFRI investigators: Steve Colombo, Tom Noland, and Paul Sampson. Partners/cooperators: Other MNR units (Southcentral Science Section, Forest Management Branch, Forest Resources Inventory); Centre for Research in Earth and Space Technology/York University, North York, Ontario; Canadian Forest Service, Sault Ste. Marie/Newfoundland; Ontario Ministry of Environment and Energy, Brampton, Ontario; California State University, Los Angeles.

Changes in forest management could help minimize effects of climate change

By Abigail M. Obenchain

If predictions for climate change come true, a seedling in Sudbury could be growing in a climate similar to Windsor's before the end of the next century, says a new report, *The Impacts of Climate Change on Ontario's Forests* (OFRI Forest Research Information Paper No. 143). However, the report also suggests that forest managers will be able to help mitigate some of the effects of climate change.

"There's little dispute that CO_2 levels will double by the end of the next century; what's less clear is how quickly and to what extent this will alter Ontario's climate and affect its forests," says scientist Steve Colombo, who organized the science discussion group that produced this report. The group consists of representatives from OFRI, MNR's Forest Management Branch, and the Canadian Forest Service and has met regularly over the last year to discuss forest science issues related to climate change.

OFRI's Chris Papadopol, another scientist in the group, explains that since the mid-19th century, humans have burned enormous amounts of fossil fuel, releasing large amounts of CO_2 into the atmosphere. At the same time, human activities like agriculture and urban development have diminished many of the Earth's forests. Since trees are important CO_2 *sinks* (they *sequester* or take in and store CO_2 for long periods of time), the loss of forests has reduced the Earth's ability to accommodate increases in CO_2. As a result, by the end of the next century, the amount of CO_2 in the atmosphere is predicted to double. If this and other "greenhouse" gases continue to accumulate rapidly, the average global temperature is predicted to rise from 1 to 5° C over the next 50 years. The warmer temperatures are predicted to accelerate the global water cycle, which could cause both increases and decreases in rainfall, depending on the region. For example, scientists are forecasting that northeastern Ontario may be hotter and wetter, while northwestern Ontario may be hotter and *drier*.

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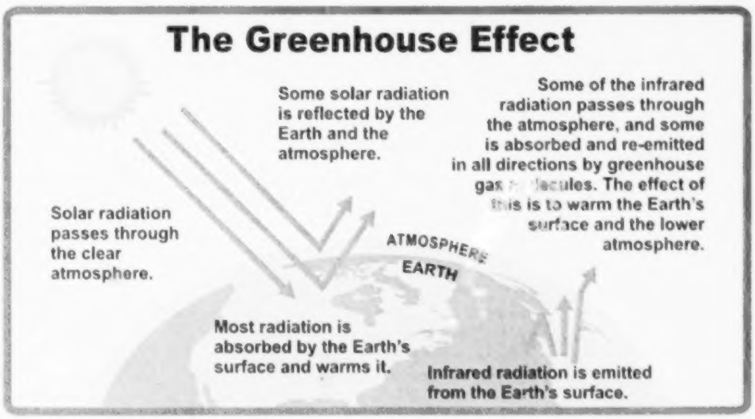


Scientists are also concerned that weather may become more extreme and *more variable* — and that this variability may be an even greater cause for alarm than the rising temperatures. "What if trees regularly begin breaking bud in March but experience hard frosts in April?" Colombo asks. "Or the frequency of severe drought increases, leading to reduced growth and greater stress, in turn causing more frequent and severe fires, insect outbreaks, and disease?"

Resource-management issues related to climate change include:

Wood supply: A warmer, wetter climate *could* increase forest productivity, benefiting forest industry. However, an area that becomes hotter and drier could have more fires and pest outbreaks, with potential economic consequences. Climate change could also affect the *mix* of commercially valuable species. For example, in some areas, boreal conifer forests could become aspen parklands, again possibly affecting the people who live and work in the region.

Land-use planning: If climate change alters which plants and animals live where, the allocation of harvest areas, parks and other tourism areas, natural areas, etc., will have to be re-evaluated.

Changes in valued species/biodiversity: Some rare species may disappear from Ontario; others may thrive. The loss of genetic diversity, already a concern for some species, may accelerate in some areas. The migration of species northward may increase species and ecosystem diversity.

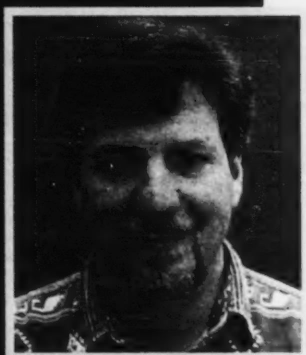
Both Colombo and Papadopol caution that ecosystems and climate patterns are incredibly complex, thus even the best computer models may have trouble predicting how ecosystems will change and what the ecological and economic consequences could be. "The information gaps are huge," Colombo says. "We need to develop much more accurate predictions specific to Ontario's forests, improve our systems for monitoring forest condition, and develop sound forest management recommendations based on the best available scientific information."

Recommendations could include reducing the amount of time between harvest and regeneration; improving fire-management strategies; and maximizing forest productivity through the increased use of vegetation and pest management, genetically improved stock, and thinning. "Anything that reduces stress and increases the growth rates of our forests will help sequester more CO_2," Papadopol says.

Other possible interventions: New pest-management, regeneration, and silvicultural strategies designed to help desired species maintain their genetic diversity (and thus adaptability to new conditions), help at-risk stands to survive in changing conditions, and/or promote the migration of at-risk species to more appropriate areas.

For more information, contact Steve Colombo (ext. 218; e-mail: colombs@gov.on.ca) or Chris Papadopol (ext. 224; papadoc@gov.on.ca) at OFRI. Other OFRI staff in the discussion group: Marilyn Cherry, Sylvia Greifenhagen, Bill Parker, Changhui Peng, David Smith, Michael Ter-Mikaelian. Other members include representatives of MNR's Forest Management Branch and the Canadian Forest Service in Sault Ste. Marie.

OFRI Staff Profile: STEVE COLOMBO



OFRI research scientist Steve Colombo has dedicated most of the last 25 years to working for MNR, beginning as a Junior Ranger at a camp near Elliot Lake in 1972. A scientist for the last 18 years, he has specialized in tree stress physiology, stand establishment, and nursery crop management. During the 1980s, Steve helped to develop the *extended greenhouse culture hardiness regime*, which speeds frost hardiness in seedlings, an innovation that has greatly improved seedling quality and reduced overwinter mortality. From 1992-96, Steve lead the award-winning Stock Quality Assessment Program, which resulted in the application of operational techniques for assessing and rating the health of seedlings. In 1996, Steve received an Amethyst Award, an honour that goes to Ontario Public Service staff who have made exceptional contributions in the areas of professional leadership, innovation, and client service.

Today, Steve is a principal investigator with OFRI's Bioindicators Project, the goal of which is to develop practical ways to assess forest condition (see related article on Page 2).

Ontario's Forest Growth and Yield Program:

Gearing up for the 21st century

By Abigail M. Obenchain

During the 1980s, governments and forest industry began to feel increasing pressure to demonstrate that they were practicing *sustainable* forestry: forest management that sustains ecosystems and all their values at various scales, from the individual forest stand to the province as a whole. Two of the related science needs were provincially consistent, scientific information about how timber supply and the productivity of the forest itself change over time *and* computer models to help forest managers predict and enhance future productivity. At that time, however, little information and few tools existed. Although growth and yield research dates back more than 70 years in Ontario, data from these existing studies could not be linked to provide a provincial profile or even to compare one region to another.

Senior research technician Jim Hayden describes the growth and yield plot design to a visiting Finnish scientist. This plot is located in a managed yellow birch stand north of Sault Ste. Marie, and is part of Ontario's growth and yield permanent sample plot network.

1991: Ontario establishes a provincial growth and yield program

To address the need for provincially standard information on forest productivity, the MNR set up a new and ambitious *forest* growth and yield program in 1991. A series of workshops attended by MNR staff as well as several international growth and yield experts resulted in the publication of *A Master Plan to Examine Forest Growth and Dynamics in Ontario* in 1993. This plan called for MNR to establish a network of 4,000 permanent sample plots that would represent the range of forest conditions in Ontario. The plots would be re-measured every 5 years for up to 100 years, resulting in a provincial growth and yield database to support the development of a comprehensive library of growth and yield models.

OFRI became the coordinator of the provincial program, and each MNR region hired a growth and yield coordinator to implement a program addressing regional information and modelling needs.

In 1994, Ontario's Environmental Assessment Board published *The Class Environmental Assessment for Timber Management on Crown Lands in Ontario,* which included a legal requirement for a provincial growth and yield program. Work on the plot network went into full swing, and by 1995, the program had established just over 1,000 permanent sample plots, upgraded numerous historic plots to the current standards, published a comprehensive *Field Manual for Establishing and Measuring Permanent Sample Plots* and *Quality Assurance Procedures for Permanent Sample Plots,* and begun compiling a provincial growth and yield database. At both the regional and provincial levels, the development of models was becoming increasingly important; projects included regional yield curves, local volume tables, site index curves and density management diagrams for several tree species.

1996: New challenges, new opportunities

In 1996, the Ontario Forest Growth and Yield Program began to face a series of challenges, says OFRI's David Smith, a research scientist with the program. Like many government programs, it experienced budget and staff cuts requiring tough decisions about issues like whether a reduced plot network would still allow the program to meet its objectives. In addition, questions arose about whether the existing plot design and sampling methods needed revision.

At the same time, demand for information and decision-support tools related to forest productivity was increasing — and still is. Ontario's wood supply is now predicted to fall

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short of demand over the next 20 years. What's more, forest industry has begun working toward a "green stamp" (certification of sustainable forest management by the Canadian Standards Association or other certifying body; see *Insights*, Vol. 2, No. 2) to compete in today's environmentally conscious global economy. To get and retain this certification, companies must be able to predict not just timber supply but also biodiversity, wildlife habitat, and other ecological and social values. Growth and yield-related data and models are a major requirement of all "green stamp" evaluations.

1998: Preparing for the new millenium

Rather than seeing these challenges as obstacles, Smith chooses to see them as opportunities. "This is a very exciting time for us; we're beginning to move in some very interesting new directions. The question is, how can we adapt to today's fiscal realities and still get the job done?"

To help answer this question, earlier this year Smith organized a workshop and invited provincial and regional growth and yield staff; some key MNR, Canadian Forest Service, and university partners; and internationally renowned experts in forest mensuration, plot design, and sampling methodology. The objectives: to review current analytical, modelling, and statistical procedures; review the plot design and sampling methodology; and help establish future direction for the program. The results, according to Smith:

- The program's **plot design** was declared "a *wonderful* design for modelling purposes" by plot design expert Margaret Penner, a private consultant in Ontario and former Petewawa National Forestry Institute scientist, and sampling methodology expert Charles T. Scott of the U.S. Forest Service.
- Penner and Scott also concluded that that the **sampling intensity** for some types of data can be scaled back, thus reducing remeasurement costs without affecting the validity of the database.
- **Forest Ecosystem Classification (FEC) plots** will be incorporated into growth and yield plots, allowing the FEC and growth and yield programs to link more closely (FEC plots are designed to help develop standardized means for mapping, classifying, and describing Ontario's ecosystems at various scales). The benefits of this linkage will include reduced costs for establishing plots, collecting data, and developing models.
- Using the workshop results, Lakehead University mensuration professor Gary Murchison will re-calibrate a **cost-optimization model** he created to ensure a cost-efficient and effective plot design and sampling intensity.
- Over the next year, the **field guide** and the **quality assurance procedures** will be revised to reflect the above changes. In addition, guidelines for preparing data for growth and yield analyses and fitting/interpreting yield curves will be published. Discussions are underway concerning the referencing of these 3 sets of guidelines in MNR's forthcoming *Forest Information Manual*, thus providing standardized procedures for collecting growth and yield data in Ontario. According to Smith, this standardization would "enhance our ability to produce a provincial library of growth and yield models and help industry to be in a far stronger position to defend their 'green stamp.' "

In addition, regional growth and yield staff have been helping Ontario's forest industry to **simplify the definition of a forest unit.** As a result, the number of forest unit types will drop dramatically, making it much simpler and less expensive to ensure the plot network represents the range of Ontario conditions and to implement standard data-collection methods and models.

What's more, a **partnership with Forintek Canada,** a forest-products research lab, will result in the incorporation of product-quality models into Ontario's density management diagrams, which are used to determine how and when to thin trees to produce the desired end product (now available for jack, red and white pine and available in 1999 for trembling aspen and black spruce). "Product quality is becoming an increasingly important issue, particularly given the predicted wood supply shortage and increasing pressures to take more land out of productive forestry," Smith explains. "These models will help forest managers to manage tree density to enhance wood quality as well as volume growth, depending on whether the desired end product is veneer, sawlogs, or pulp. For example, we hope to be able to predict knot density, a critical issue for veneer production."

The first stage of the project will focus on jack pine and black spruce. These 2 models are expected to be released as user-friendly Windows-compatible software within 2 years.

For more information about the provincial growth and yield program, contact David Smith at OFRI (ext. 118; e-mail: smithda@gov.on.ca). For information on the regional programs, contact Murray Woods, MNR Southcentral Science Section, North Bay, and John Parton, MNR Boreal Science Section, South Porcupine. The growth and yield master plan, field guide, and quality assurance procedures are available from OFRI. For the red and white pine density management diagrams, contact Lyn Thompson, MNR Southcentral Science Section, (705)475-5560. For the jack pine diagram, contact Karen Punpur, MNR Boreal Science Section, (807)939-3106.

OFRI publishes comprehensive list of Ontario's plant species

By Abigail M. Obenchain

If you are a forester, botanist, ecologist, naturalist, or *anyone* who collects data on plants, then you'll want to get your hands on the *Ontario Plant List*, published recently by OFRI. "This book will be an incredibly useful tool," says botany consultant and lead author Steve Newmaster, who is now working at OFRI. "As interest in and concern for biodiversity have increased, so has the need for a standard manual of plant names. Finally, there is a single, comprehensive plant reference for the province."

More than 800 pages long, the soft-bound *Plant List* includes more than 4,700 entries, including club mosses, ferns, grasses, herbs, hornworts, horsetails, lichens, liverworts, quillworts, rushes, sedges, shrubs, and trees. For each species, the book provides the current Latin name, up to 4 Latin synonyms, and common English and French names (if available). Also provided: a wide range of identifiers, such as unique vegetation alpha codes (the standard plant identifier that *anyone* collecting data in Ontario should use); links to MNR's Natural Resource Values Information System (NRVIS); codes for rare, threatened and endangered species; and identifiers relating to medicinal values. In addition, the book gives an overview of Ontario's landscape, geology, soils, climate, and vegetation patterns and describes the unique characteristics of each major plant group.

According to co-author Ago Lehela, a retired OFRI research technician who is now a private consultant, the *Ontario Plant List* project has been a massive undertaking, begun more than 15 years ago. At that time, Lehela was monitoring the environmental effects of herbicides for MNR's former Pest Control Section, and he quickly realized that to complete the project, he needed to compile a computerized, coded list of relevant plant species.

In 1994, Lehela linked up with Newmaster, then an independent botany consultant, while both were working with OFRI's Vegetation Management Alternatives Program. Other partners soon jumped on board, bringing funding, expertise, and/or their own plant lists. They included staff with OFRI's Forest Growth and Yield Program, which monitors how forests grow and change over time; Peter Uhlig and Sean McMurray of MNR's Ecological Land Classification (ELC) Program, which is developing standardized means for mapping, classifying, and describing Ontario's ecosystems at various scales; and Mike Oldham of MNR's Natural Heritage Information Centre, which monitors rare, threatened, and endangered species, vegetation communities, and natural areas. A variety of professional and amateur botanists assisted the *Plant List* authors by providing information or reviewing parts of the list. The goal was to create a master list of Ontario's plants that would support and help link MNR research programs to each other, and ultimately, contribute toward a common botanical language for all resource professionals. Some of the envisioned applications include:

- **Expanding the focus of research from forests to ecosystems:** Increasingly, research projects must look at all elements of the ecosystem, not just the trees. Consistent data standards for describing these other aspects (e.g., vegetation) are critical yet currently scarce.
- **Assessing sustainability:** Several criteria for evaluating sustainable forestry relate to vegetation (e.g., conserving biodiversity, maintaining ecosystem condition, providing multiple benefits to society). To

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evaluate these criteria, consistent standards for collecting and coding vegetation data are a must.

- **Linking research initiatives:** With consistent vegetation codes, growth and yield, ELC, NRVIS, and other related projects can share data more easily. What's more, they can have greater confidence in comparing the results of similar studies conducted in different regions.
- **Scaling up computer models:** If consistent vegetation codes are used in plots across the province, scientists can more easily link datasets to create models that predict vegetation growth and change at broader scales.
- **Locating rare or desired species:** Consistent coding will help Natural Heritage staff to locate and protect populations of rare, threatened, or endangered plant species and help scientist locate potential sites for medicinal plant studies.

The *Ontario Plant List* costs $30. To obtain a copy, contact the Natural Resources Information Centre, Ministry of Natural Resources, P.0. Box 7000, 300 Water St., Peterborough, ON K9J 8M5, phone (705)755-1662, fax: (705)755-1677, e-mail nricmn@epo.gov.on.ca. A digital *Plant List* database should be available by fall 1998.

For more information about the Plant List, *contact Steve Newmaster at OFRI (ext. 244; e-mail: ofriin@gov.on.ca); for more information about the digital database, contact Sean McMurray (ext. 226; e-mail: mcmurrs@gov.on.ca). Other partners: Plant Community Consultants, Ltd., Sault Ste. Marie; MNR's Forest Management Branch, Sault Ste. Marie; MNR's Natural Heritage Information Centre, Peterborough.*

UPCOMING EVENTS

September 21-24

Sustainable Resource Management: Striking a Balance — MNR NEST Workshop Week; Senator Hotel, Timmins; sponsored by MNR's Northeast Science and Technology Unit and the Canadian Institute of Forestry's Northern Ontario Section; keynote speaker: renowned author and speaker Dr. Patrick Moore of British Columbia; guest speaker: Dr. Peter Duinker, Lakehead University professor and Chair in Forest Management and Policy; a total of 23 workshops will address a broad range of resource management science topics including: silviculture effectiveness monitoring; fish habitat and fisheries assessment; operational snag management; facilitating community decisionmaking processes; developing silvicultural strategies, etc. Contact: Gisele Berry, (705)235-1229, e-mail berryg@gov.on.ca.

Boreal Science Section Workshops *(to register contact Karen Punpur at (807)939-3106):*

September 24-25

Space to Grow, the Sequel: Thinning in Ontario's Boreal Forest; Victoria Inn, Thunder Bay (for MNR/forest industry)

September 30-October 1

Landscapes in Northwestern Ontario; SIRD Computer Training Center, Thunder Bay (for MNR staff)

October 5-8

Caribou Guidelines; Sioux Lookout (for MNR/forest industry)

November 23-27

Science for Planning Workshop; Nor'Wester Hotel, Thunder Bay (for MNR FMP teams, 2000-2)

New faces at OFRI

John McLaughlin, the new acting provincial forest science pathologist, will be working on a variety of forest disease issues, including root disease management, white pine blister rust, and disease/wood decay implications of the ice storm damage in southeastern Ontario. Before joining OFRI, he was a forest health consultant in British Columbia; from 1995-97, he was British Columbia's provincial forest pathologist. John is filling the shoes of **Tim Meyer,** who has taken an 18-month assignment as OFRI's manager for program and policy development.

Steve Newmaster is a forest botany consultant who is working on contract at OFRI; he plans to focus on plant biodiversity and disturbance ecology. His previous projects include being the lead author of OFRI's recently published *Ontario Plant List* (see related article in this issue) and working on his PhD at the University of Alberta in Edmonton. Steve says, "If anyone is having difficulty identifying plant species, my door is always open."

Have a suggestion?

Want more information on a research project?

We want to hear from you!

CONTACT: ***Insights*** Editor
(or the specific OFRI researcher)
Ontario Forest Research Institute
1235 Queen Street East
Sault Ste. Marie • Ontario • P6A 2E5
CANADA • Phone: (705) 946-2981
Fax: (705) 946-2030
E-mail: ofriin@gov.on.ca

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